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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10 034,497	12 28 2001	In Cheol Ryu	CU-2756 VE	1250

26530 7590 05 19 2003

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EXAMINER

QUACH, TUAN N

ART UNIT PAPER NUMBER

2814

DATE MAILED: 05.19.2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/034,497

Applicant(s)

RYU ET AL.

Examiner

Tuan Quach

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 11 March 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-5, 7-14, 16-19 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5, 7-14, 16-19 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

### DETAILED ACTION

Claims 4 and 13 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

These claims are improper dependent claims as they do not incorporate all the limitations of the independent claims 1 and 10.

Claims 5 and 14 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. There is no support for the process now claimed in claims 5 and 14 in the context of independent claims 1 and 10 wherein a plasma treatment is continued after the formation of the glue layer. See the specification page 10 lines 2-5 which only discloses that a plasma treatment can be performed during or after the deposition of the TiN layer and does not disclose a plasma treatment during the deposition of the TiN and is continued after the deposition of the TiN layer.

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action. Also, "et al." after a reference's name is omitted.

Claims 1-5, 7-14, and 16-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art taken with Ho, Zhang, Zhao, and Bakli.

The admitted prior art (APA) shows the formation of contact holes including through insulating layers 3 and 7 to form contact hole 11b and through conductor 5 and insulating layer 7 to form contact hole 11a as shown in Fig. 1 and the specification page 2 lines 10 to page 3 line 8. The admitted prior art thus lacks anticipation primarily in that it does not teach the use of CVD TiN and tungsten for conductor plugs and the plasma treatment of the TiN.

Ho teaches the formation of tungsten plugs in interlayer dielectric including the provision of CVD titanium nitride barrier; the use of additional PVD titanium nitride by plasma vapor deposition is also taught. See column 1 lines 21-50 and column 2 lines 36 to column 3 line 25.

Zhang teaches forming CVD titanium nitride and plasma treatment in nitrogen and hydrogen for removal impurities and for film densification. In-situ treatment is also taught. See column 7 line 60 to column 14 line 14, particularly column 9 line 56 to column 10, line 9, column 11 line 48-62. The application in contact holes and W metallization is also taught, column 13 line 65 to column 14 line 3.

Zhao teaches the plasma treatment of TiN including hydrogen and nitrogen to improve its quality. The inclusion of a titanium e.g., layer 106 with the titanium nitride, e.g., layer 108 is also shown. See column 3 lines 50 to column 4 line 32.

It would have been obvious to one skilled in the art in practicing the admitted prior art process to have included the conductor plugs comprising CVD TiN and tungsten for such conductor plugs since such conductive structures are conventional and advantageous as shown in Ho and Zhang wherein tungsten plugs having improved

characteristics over high aspect ratio openings can be obtained. The CVD TiN of the same material and deposition process would also function as the glue layer, absent evidence to the contrary, and as it is well known that such TiN would function as glue as well. The inclusion of a PVD TiN with the CVD TiN is well known and advantageous as shown in Ho. It would have been obvious to one skilled in the art in practicing the above process to have included the plasma treatment and the titanium layer since such is well known and advantageous as taught by Zhao and Zhang.

Regarding the plasma treatment during or after deposition, such corresponds to one out of two obvious alternatives and as such would have been obvious. Furthermore, such would have been obvious given the teachings of Zhao supra wherein in-situ treatment is taught, and in Bakli, column 6 lines 7-9 evidencing the plasma treatment during the deposition or as a post deposition process.

It would have been obvious and would have been within the purview of one skilled in the art to have employed well known alternative materials, e.g., as recited in claim 2. It would have been obvious and would have been within the purview of one skilled in the art to have employed well known and conventional source for CVD TiN, including various sources previously delineated in claim 4, e.g., TDMET (now incorporated in claim 1), or using a TDMAT or  $\text{TiCl}_4$  source instead of the TDMAT as now in claim 4 and as official notice was taken with regarding to such materials. This conventionality is well documented by the prior art of record, including as acknowledged by applicant in the specification, page 9 lines 22-24, which admits on the record that "the CVD process for the TiN layer 31 may use a TDMAT, TDMET or  $\text{TiCl}_4$  source, each

being well known in the art" and as further evidenced by Zhang, column 6 lines 40, column 9 lines 49, by Zhao, column 3 lines 29, column 4 lines 3-32. The provision of difference in depth, e.g., as in claim 9, would have been obvious as admitted on page 3 line 8. The use of etchant having lower etch rate would have been obvious given the teaching of conventional etchants employed and conventional conductive materials being employed. The use of PVD TiN before or after the TiN corresponds to two obvious alternatives and the selection of either one would have been obvious and would have been within the purview of one skilled in the art. Regarding the limitation in claim 5 and 14 as now claimed wherein the plasma treatment is continued after the formation of the glue layer, such is not supported by the original disclosure as pointed out above. In addition, it would have been conventional and obvious as evidenced by Bakli as delineated above wherein the use of plasma during the deposition or post deposition plasma treatment and thus the continued plasma treatment after the deposition if desired would correspond have been obvious over the teaching of Bakli as delineated above and would have been further obvious and would have been within the purview to effect a plasma treatment of a desired or extended duration beyond the deposition stage, given the teachings of Zhang, column 8 lines 62 to column 9 line 56 wherein the over-treatment is conventional and advantageous to obtain film having lower stress.

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over APA taken with Ho, Zhao, Zhang, and Bakli as applied to claims 1-5, 7-14, and 16-19 above, and further in view of Hashfield or Tsai.

The prior art is applied as above and do not recite thermal treatment as in claim 19.

Harshfield teaches rapid thermal treatment of TiN to stabilize the film by combining any residual reactants therein. See column 4 lines 3-8, lines 53-58.

Tsai teaches thermal treatment herein titanium layer deposited can react to form silicide; the use of CVD TiN is also taught. See column 5 lines 21-40.

It would have been obvious to one skilled in the art in practicing the above process to have included a thermal treatment before or after the CVD TiN since such processing is well known and advantageous wherein improved TiN can be obtained and wherein titanium silicide can be obtained. RTP or tube annealing and annealing before or after correspond to two conventional alternatives for annealing and processing sequence and the selection of two possible alternatives would have been obvious.

Applicant's arguments filed March 11, 2003 have been fully considered but they are not persuasive.

Applicant argues that Bakli does not teach plasma treatment during CVD of titanium or titanium nitride. The alternatives of plasma treatment during or after deposition nonetheless are clearly taught in Bakli and correspond to two obvious alternatives as evidenced by Bakli column 6 lines 7-9. Furthermore, Bakli is not precluded from forming such metal nitride material and its plasma treatment in nitrogen and hydrogen to improve barrier characteristics, e.g., column 5 lines 55, column 6 lines 4-9, column 9 lines 48-55, column 11 lines 52-55. Applicant further fails to consider the

teachings of Zhang and Zhao as delineated above evidencing the conventionality of the nitride formation by CVD and plasma treatment to improve film characteristics.

Applicant further argues that Harshfield teaches a post deposition treatment and not a step that can be performed concurrently with the titanium deposition. This however overlooks applicant's own admission that the plasma treatment can be performed either during or after the deposition of the TiN layer. See the original disclosure page 10 lines 2-3. It remains apparent that the selection of one out of two possible alternatives would have been obvious as admitted. Furthermore, such is well within the purview of one skilled in the art as evidenced by Bakli as delineated above.

Applicant further argues that TDMET source is not taught by the prior art. Applicant however discloses in the original disclosure on page 9 last paragraph. To the extent that such is novel, applicant has failed to disclose how to practice such process and has failed to provide the best mode to practice such process.

**THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of



the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is 703-308-1096. The examiner can normally be reached on M - F from 9 to 5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Wael Fahmy can be reached on (703) 308-4918. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9318 (Before Final) and (703) 872-9319 (After Final).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

A handwritten signature, possibly reading 'TH', is located in the lower right quadrant of the page.